Biogas Anaerobic Digester Considerations
for Swine Farms in North Carolina

Collecting biogas from anaerobic digestion of swine manure can benefit the environment by reducing methane emissions (has potential value for equivalent carbon credits or greenhouse gas (GHG) credits), and by providing energy, as biogas is about 60 to 70 percent methane. Methane has an energy value of about 1,000 BTU/SCF[1], so biogas can have an energy value of about 600 BTU/SCF.

Plug-flow or complete-mix anaerobic digesters using metal or concrete vessels have been used on dairy and other animal farms where the dry matter or total solids content in the wastewater is over 5 percent. These types of digesters are discussed in Barker (2001), Fulhage et al. (1993), Balsam (2006), and US EPA AgStar (2008a). However, as manure becomes more diluted, the volume of the vessel increases and this increases costs.

Swine farms in N.C. typically use a flush system, either tank flush (several times daily) or shallow pit-recharge (about once per week), to transport manure from the barns. The resulting flushed wastewater is very dilute, about 98 to 99 percent water and 1 to 2 percent dry matter. The two types of digesters that are best suited for flushed wastes are: (1) In-ground ambient (or heated) covered digesters, and (2) Fixed-film digesters. Existing anaerobic lagoons can also be covered to collect biogas.

Covered Anaerobic Lagoons

Uncovered anaerobic lagoons have been used extensively in North Carolina for swine manure treatment and storage. Biogas can be collected by covering an existing anaerobic lagoon. The biogas is typically 60 to 70 percent methane (CH_4) and 30 to 40 percent carbon dioxide (CO_2). Anaerobic lagoons are designed to treat the manure and keep odor emission at a reasonable level. Loading rate of the lagoon is based on a design permanent treatment volume and is about 1 ft^3 of treatment volume per pound of Live Animal Weight (LAW) for a feeder-to-finish operation, or about 5 to 6 pounds volatile solids (VS)/1,000 ft^3 per day. Single-cell anaerobic lagoons have additional volume for manure and wastewater production for a period of time (usually 3 to 6 months), sludge accumulation (sometimes optional), temporary storage of excess rainfall (rainfall that exceeds evaporation), and runoff (if any), a 25-year, 24-hour storm rainfall and runoff amount, freeboard, and sometimes a "heavy-rainfall" amount. If there is a second cell, the wastewater storage can be subtracted from the first cell and put in the second cell. By allowing overflow to a second cell, a relatively constant volume can be maintained in the first cell.

Collected biogas from a small area (1.5 m x 1.5 m) of three swine lagoons during 1- to 3-month periods in summer indicated biogas yields of 0.10 to 0.33 ft^3 per day per square ft of area, or 0.03 to 0.04 ft^3 per day per cubic ft of lagoon volume (Safley and Westerman, 1988). Biogas production from covered swine lagoons has not been reported for full-scale projects in North Carolina.

Covered Digesters

NRCS has recommended that the design operating volume of an ambient-temperature anaerobic digester be based on either the daily VS loading rate per 1,000 ft^3 or the minimum hydraulic retention time (HRT) adequate for methane production, whichever is greater. NRCS (2003a) has recommended a 40-day minimum HRT with a maximum loading rate of approximately 10 pounds volatile solids per 1,000

[1] *SCF is "standard cubic foot," which is defined as quantity of gas in 1 cubic foot of volume at 60ºF and 1 atmosphere pressure. In this paper, gas volumes are generally reported as ft^3 because the references have not stated that volumes were converted to "standard cubic foot." The gas laws are used to convert from one set of temperature and pressure to another. Standard temperature and pressure conditions may be defined differently by various organizations.*

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